Clean energy in Vietnam after COP21, Workshop

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The clean Energy and Sustainable Development lab
University of Science and Technology of Hanoi

AIR GASICATION OF ACACIA WOODCHIPS IN AN DOWNDRAFT GASIFIER

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USTH Building :
- 9th floor, Workshop, presentation room, n°901

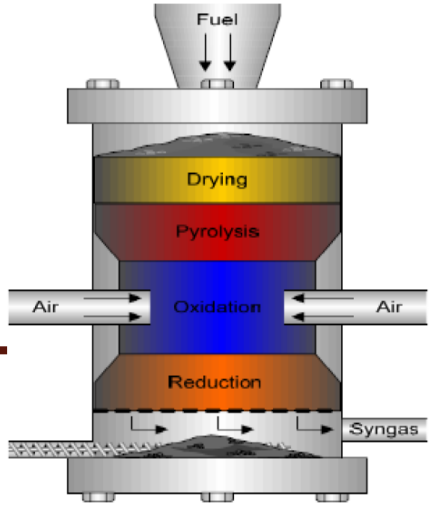
The content

1. The overview of biomass sources
2. The results of proximate and ultimate analysis of aciacia wood
3. The results of the thermogravimetric analysis of biomass and the determination of the kinetic parameters of Acacia woodchip
4. The results of experimental study of Acacia woodchips
5. The conclusion and proposals

1-THE TOTAL OF BIOMASS RESOURCES IN VIETNAM

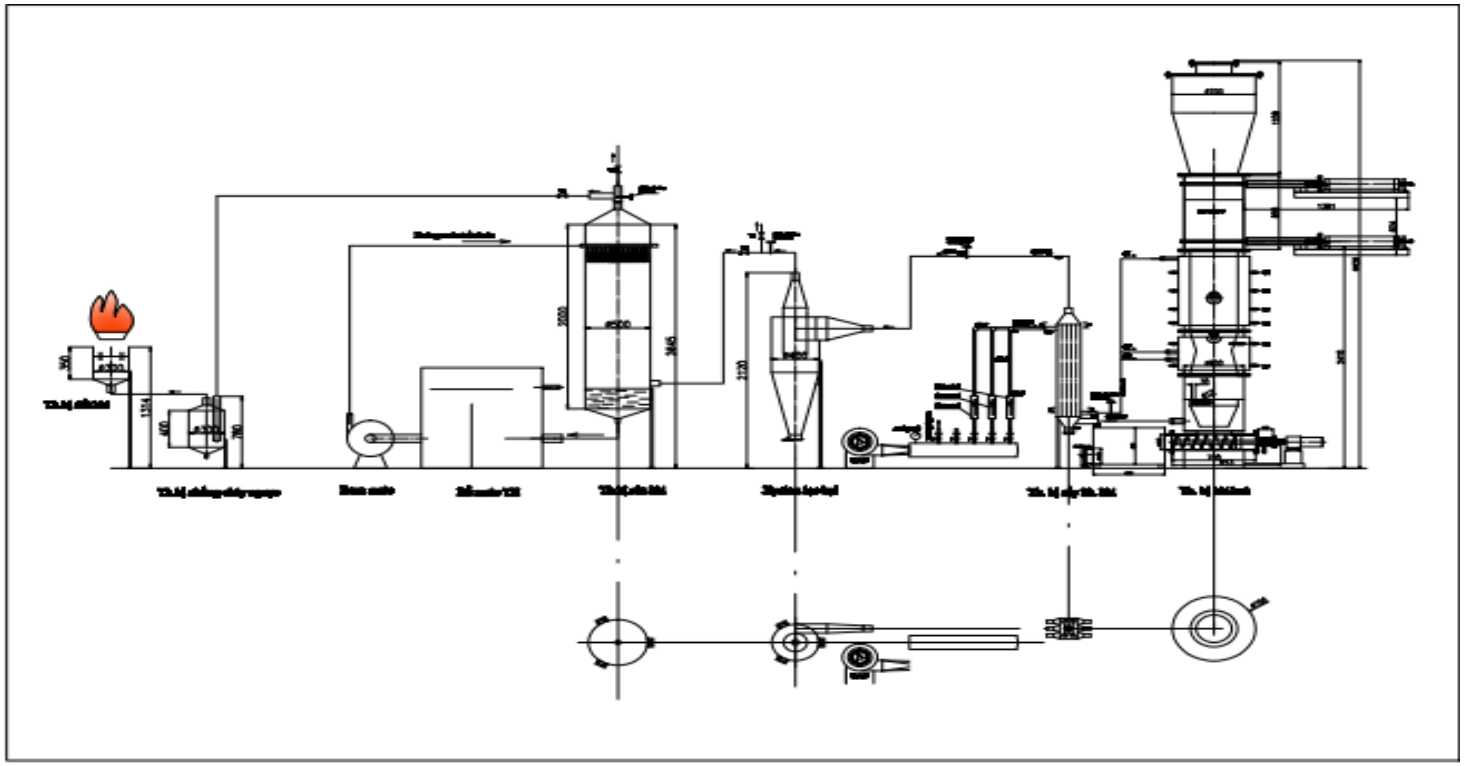
Types	Potential (million ton/yr)	the exploitation for energy(million ton/yr)	The exploitation for electricity generation (MW)
Woodchip residues	27-31	25	
Agricultural residues	72-83	58	504-581
Livestock waste	54-60	50	58
Municipial waste	7-10	8	212
Waste production	0.8-1.4	1	
Total	160.8-185.4	142	784-861

THE PROCESSING OF ACACIA WOODCHIPS



- Thermal production
- Chemical production
- Electric production

Diagram of dowdraft gasification system



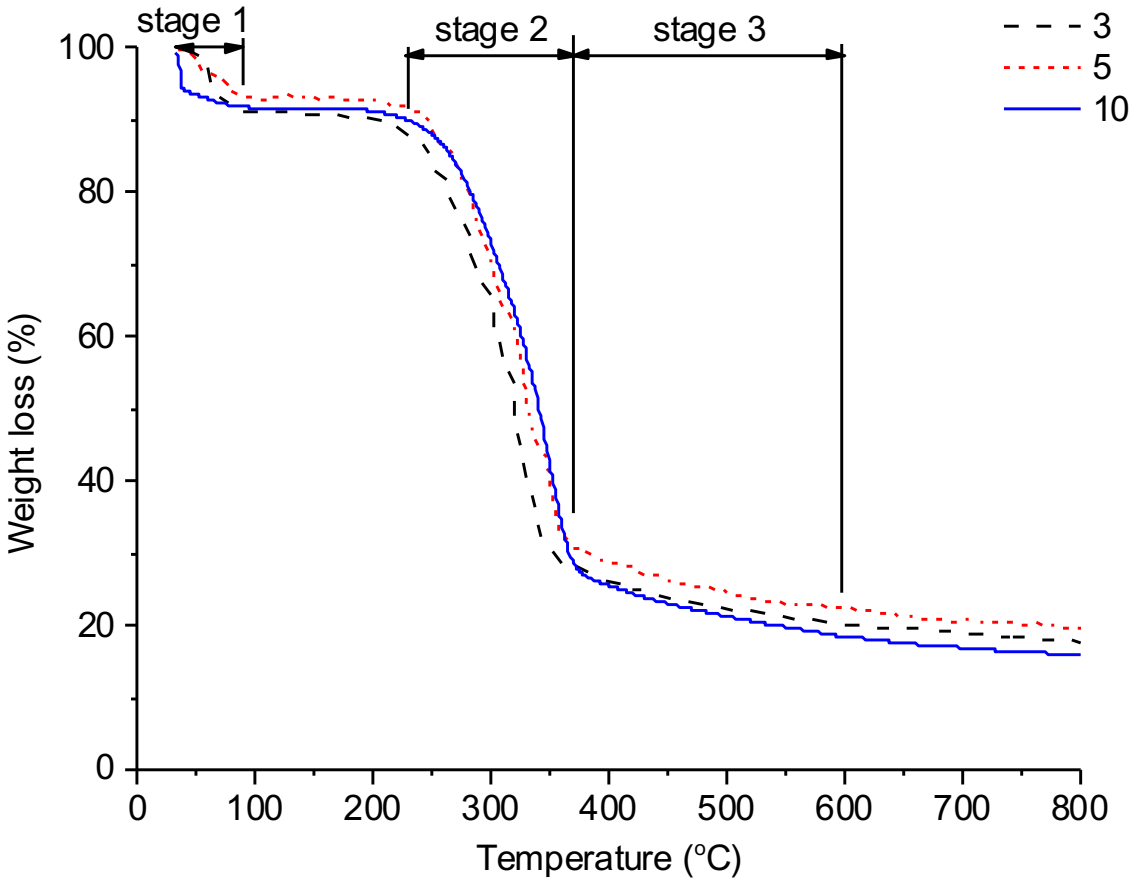
2- Proximate and ultimate analysis of biomass

Proximate and ultimate of Acacia wood

Proximate analysis	Result
Ash (%)db	0,30
Volatile matter (%)db	85,92
Fixed carbon (%)db	13,78
Moisture (%) wd	6,02

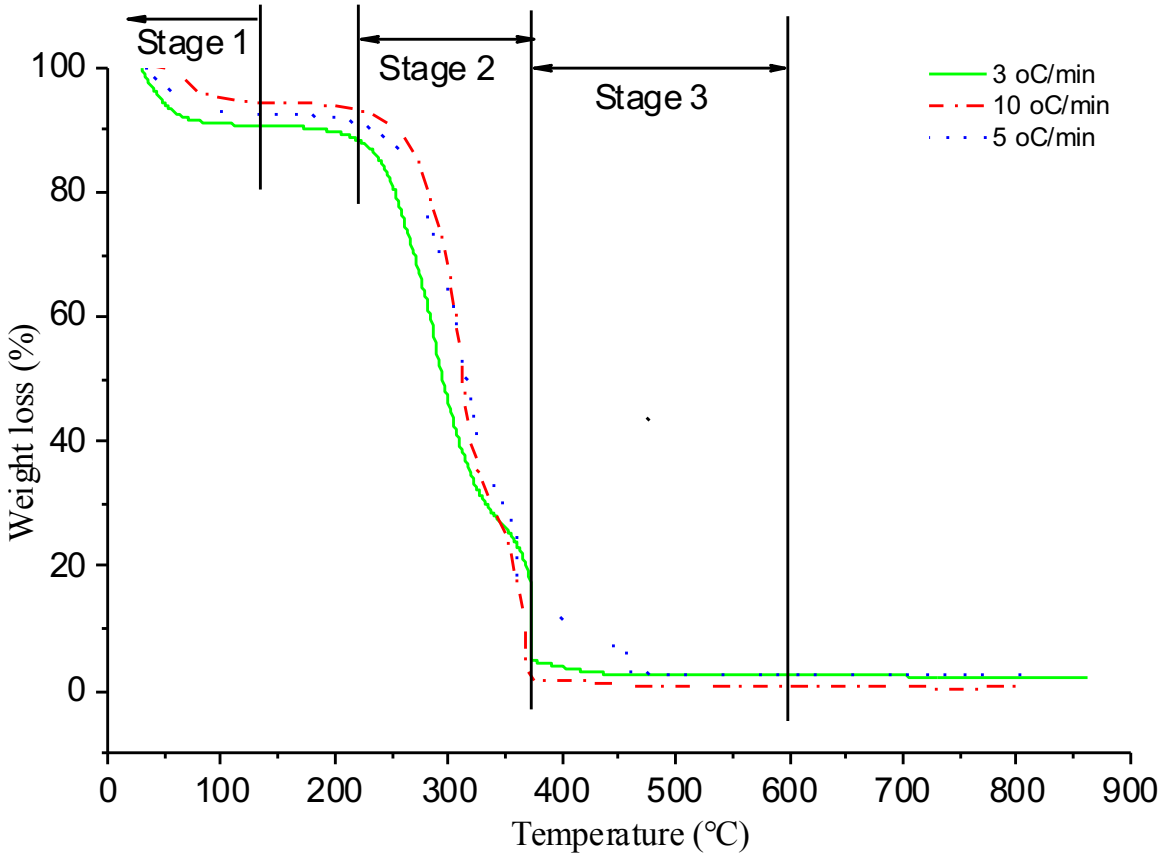
Ultimate analysis	Result
Carbon (%wt)	48
Hydrogen (%wt)	7,20
Oxy (%wt)	44,52
LHV(MJ/kg)	19,02

3- THERMOGRAVIMETRIC ANALYSIS(TGA) IN NITROGEN ENVIRONMENT FOR ACACIA WOOD



- Three reaction zone: dehydration, decomposition volatile matter and decomposition of the char
- The weight loss each zone is 10%, 55-70%, 10-20%
- The temperature of each zone is 25-150 °C, 200-400 °C, 420-800 °C

TGA ANALYSIS IN AIR ENVIRONMENT FOR ACACIA WOOD

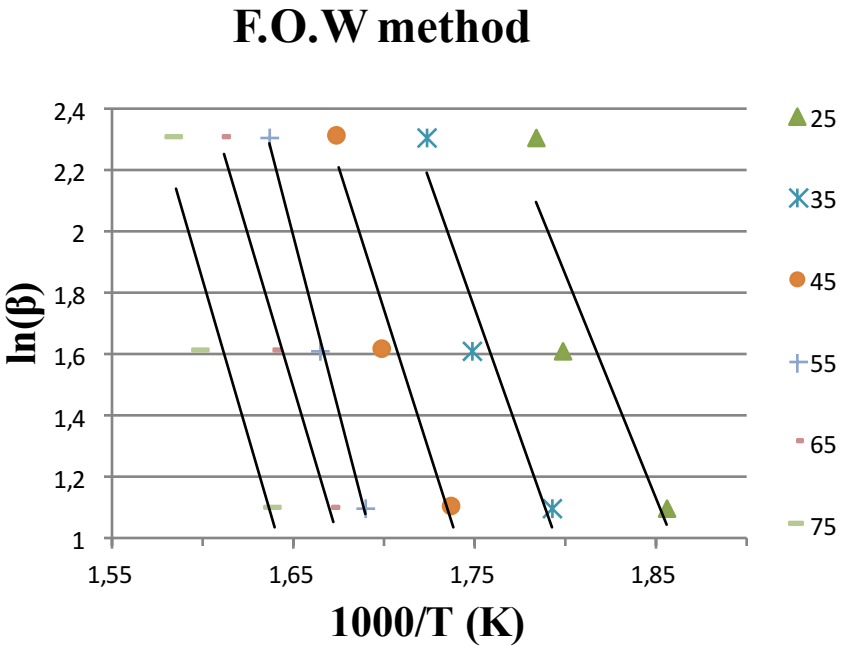


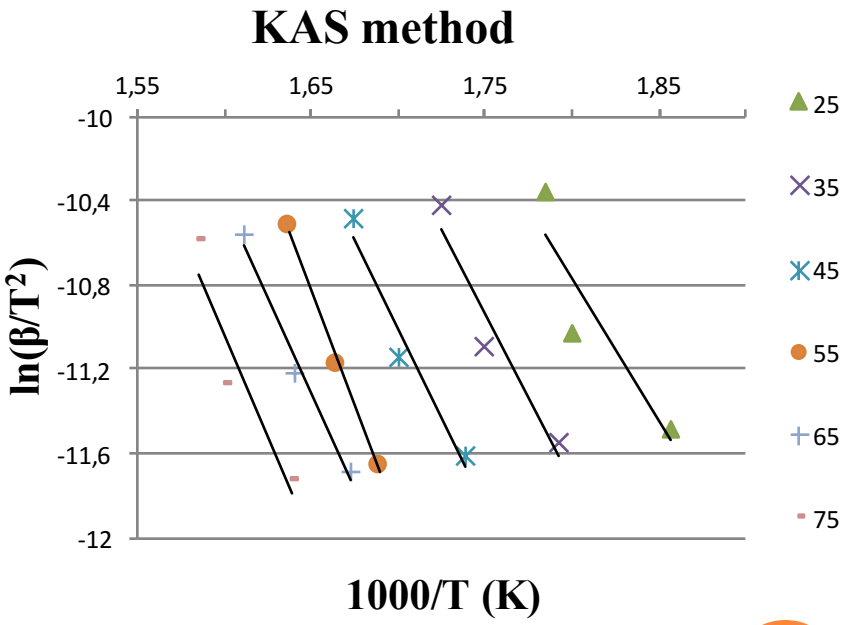
- Three reaction zone: dehydration, devolatilisation of volatile matter and combustion of char
- The temperature of each zone is 30-150°C , 210-350°C , 370-500°C
- The weight loss of each zone is 10%, 75%, 10-20%
- Above 500 °C, there is no observation of the weight loss

The determination of the kinetic parameters of Acacia woodchip

$$ln(\beta_i) = ln\left(\frac{A_\alpha E_\alpha}{Rg(\alpha)}\right) - 5.331 - 1.052\frac{E_\alpha}{RT_{\alpha i}} \quad (8)$$

$$ln\left(\frac{\beta}{T_m^2}\right) = ln\left(\frac{AR}{E}\right) - \frac{E}{RT_m} \quad (7)$$



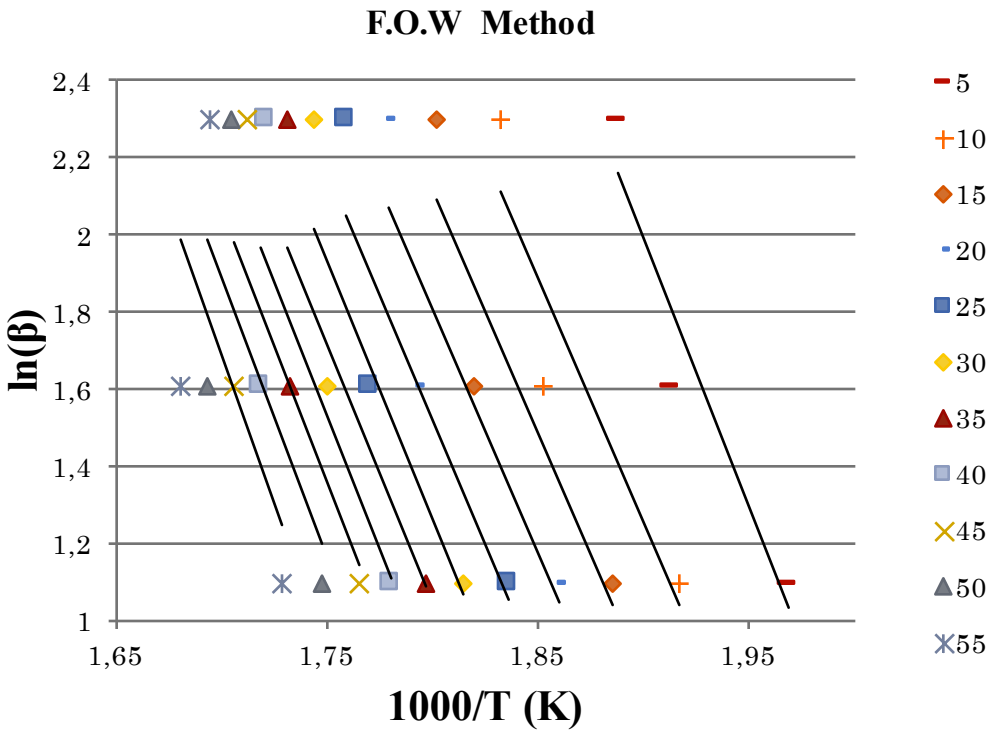


THE RESULTS OF CALCULATION ACTIVATION ENERGY

	R^2		Ea (kJ/mol)	
α	F.O.W	KAS	F.O.W	KAS
0,25	0,8433	0,8217	115,6934	112,5424
0,35	0,9401	0,932	134,1151	131,5821
0,45	0,9561	0,9504	145,9825	143,7709
0,55	0,9973	0,997	151,6044	151,9298
0,65	0,9833	0,9812	155,6915	153,5984
0,75	0,8892	0,8765	163,2658	161,3889
0,85	0,8522	0,8395	213,2022	213,5611
TB	0,92	0,91	154,69	152,14
			153,2	

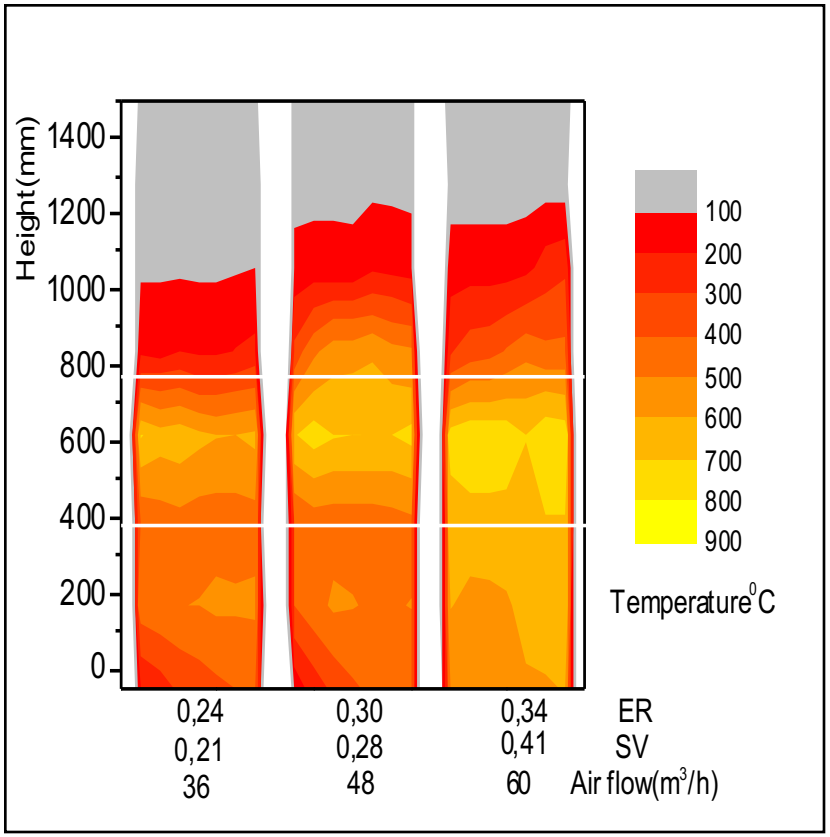
The results of two methods are the same. Activation energy, exponential factor, determination coefficient(R^2) is 153kJ/mol.

PARAMETERS IN AIR ENVIRONMENT (FWO)

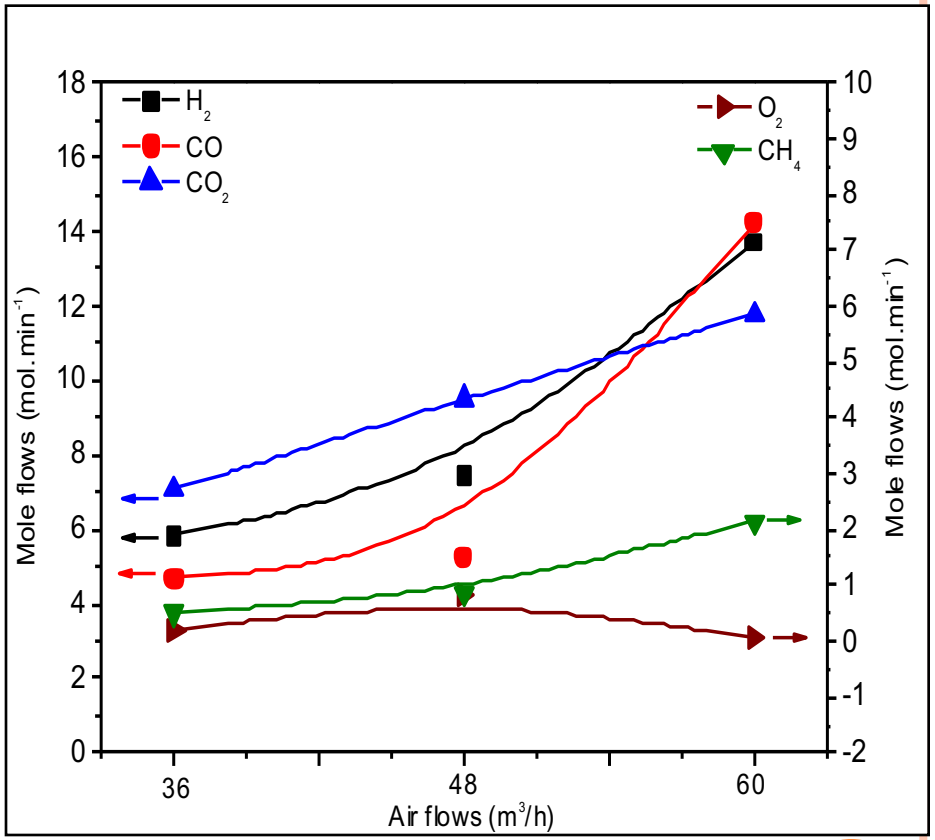


α	R^2	Ea (kJ/mol)
5	0,9082	109,67665
10	0,8605	99,880707
15	0,8377	98,718476
20	0,8166	99,920239
25	0,7886	102,64002
30	0,7467	103,98409
35	0,6889	105,3598
40	0,7467	103,98409
45	0,57	109,96128
50	0,638	108,04004
TB	**0,76**	**104,21654**

4- The results of experimental study of Acacia woodchips

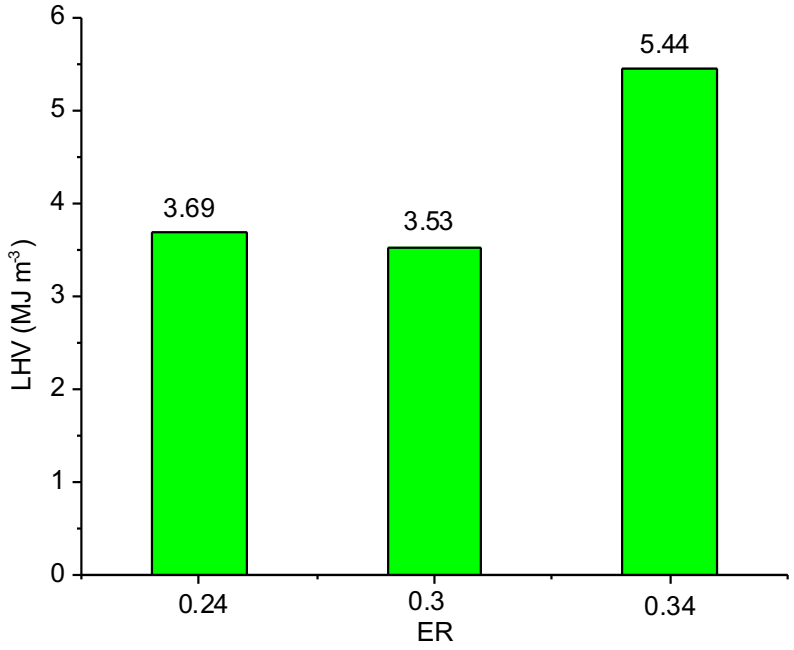


Temperature profiles in gasifier with different air flow supply

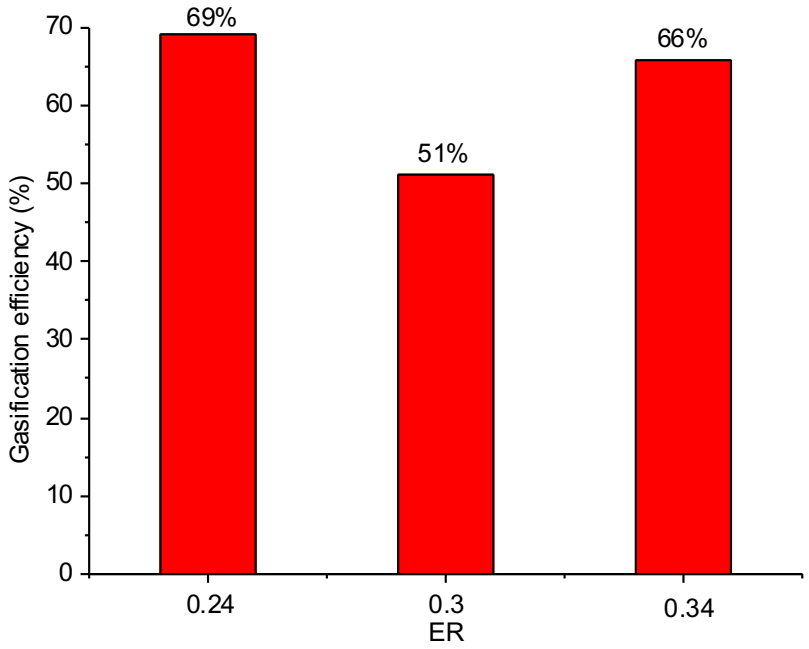


Composition of producer gas

LHV AND GASIFICATION EFFICIENCY

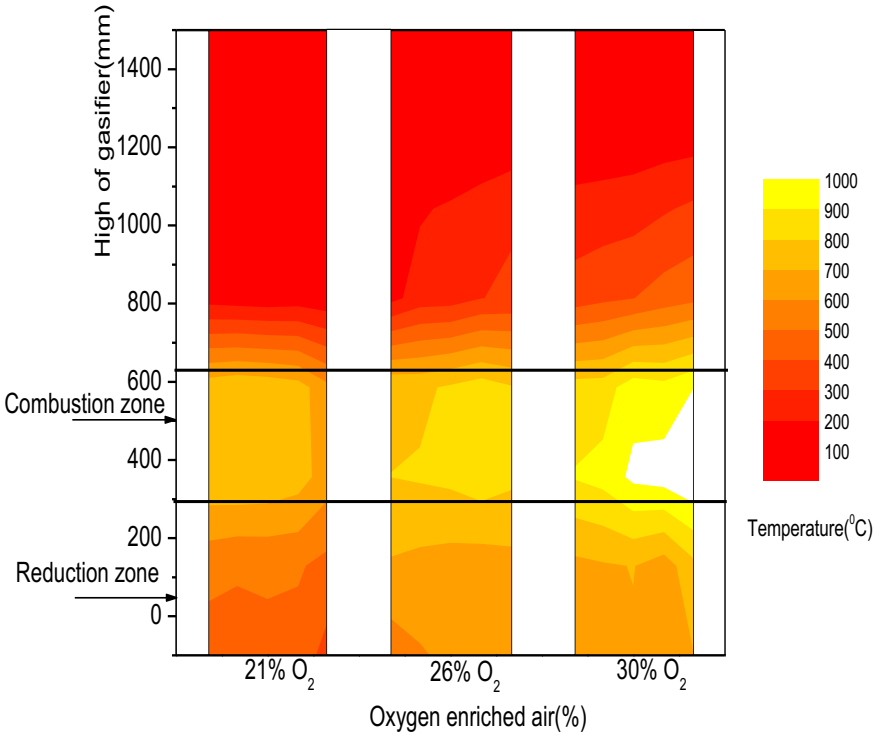


The low heating value

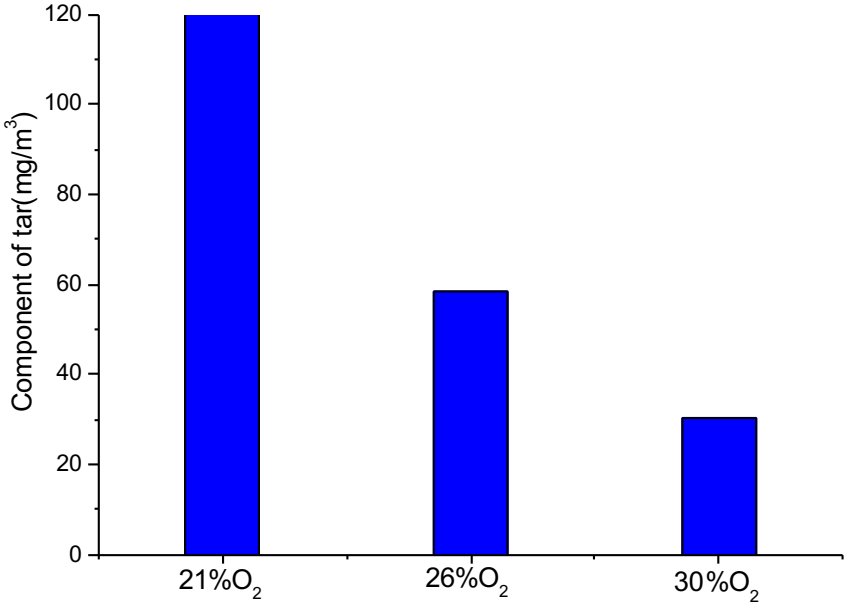


Gasification efficiency

4- The results of experimental study of Acacia for low-tar production (cont)

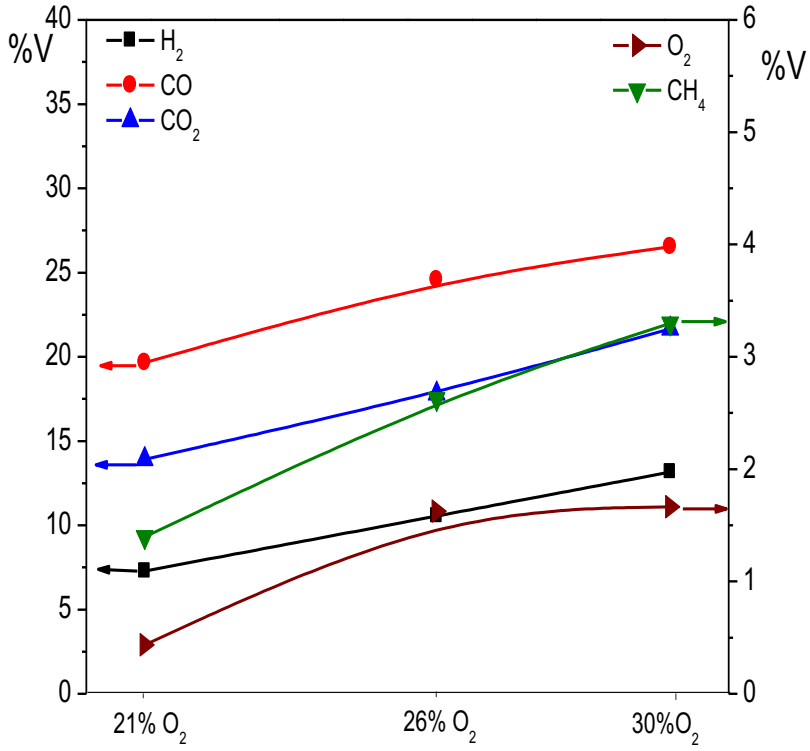


Temperature profiles in gasifier with different oxygen-enriched air



Tar content in the gasifier

THE COMPOSITION OF PRODUCER GAS



- When 30% oxygen is used, the production of combustible gas component of CO_2 , CO, CH_4, H_2 improved.

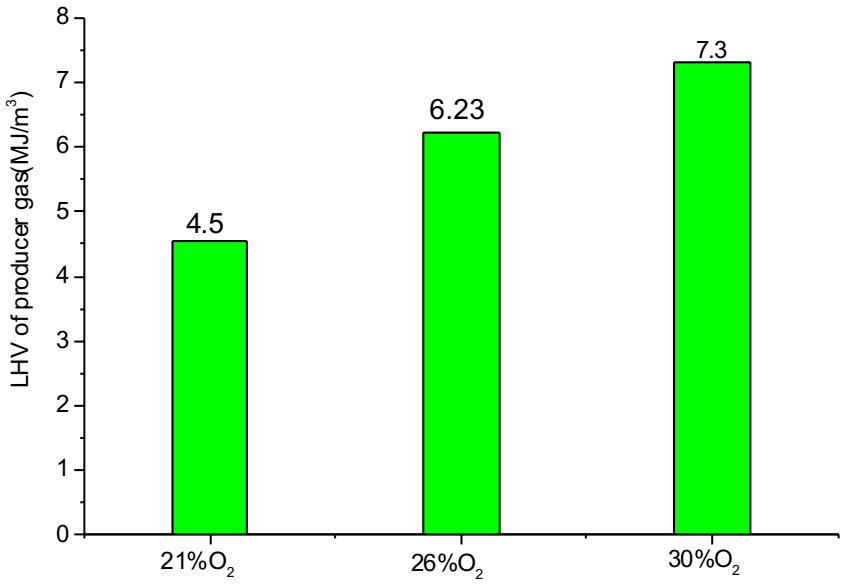
$CH_4 + H_2O = CO + 3H_2 + 206KJ/kg$

$C + H2O = H_2 + CO + 131{,}3\ kJ/kg$

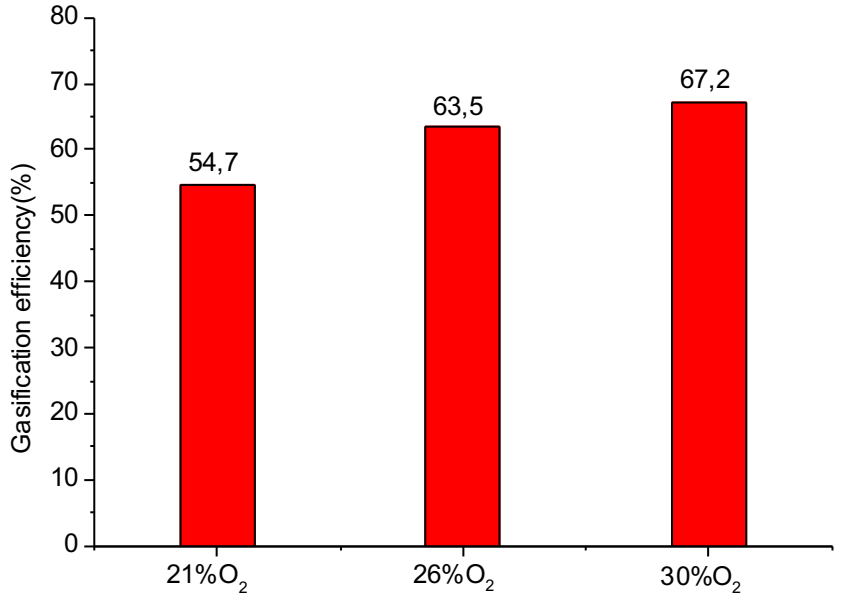
$C + CO_2 = 2CO + 172.6kJ/mol$

- The decrease in nitrogen dilution and higher temperature of combusion zone is also favor improve the quality of syngas

LHV AND GASIFICATION EFFICIENCY

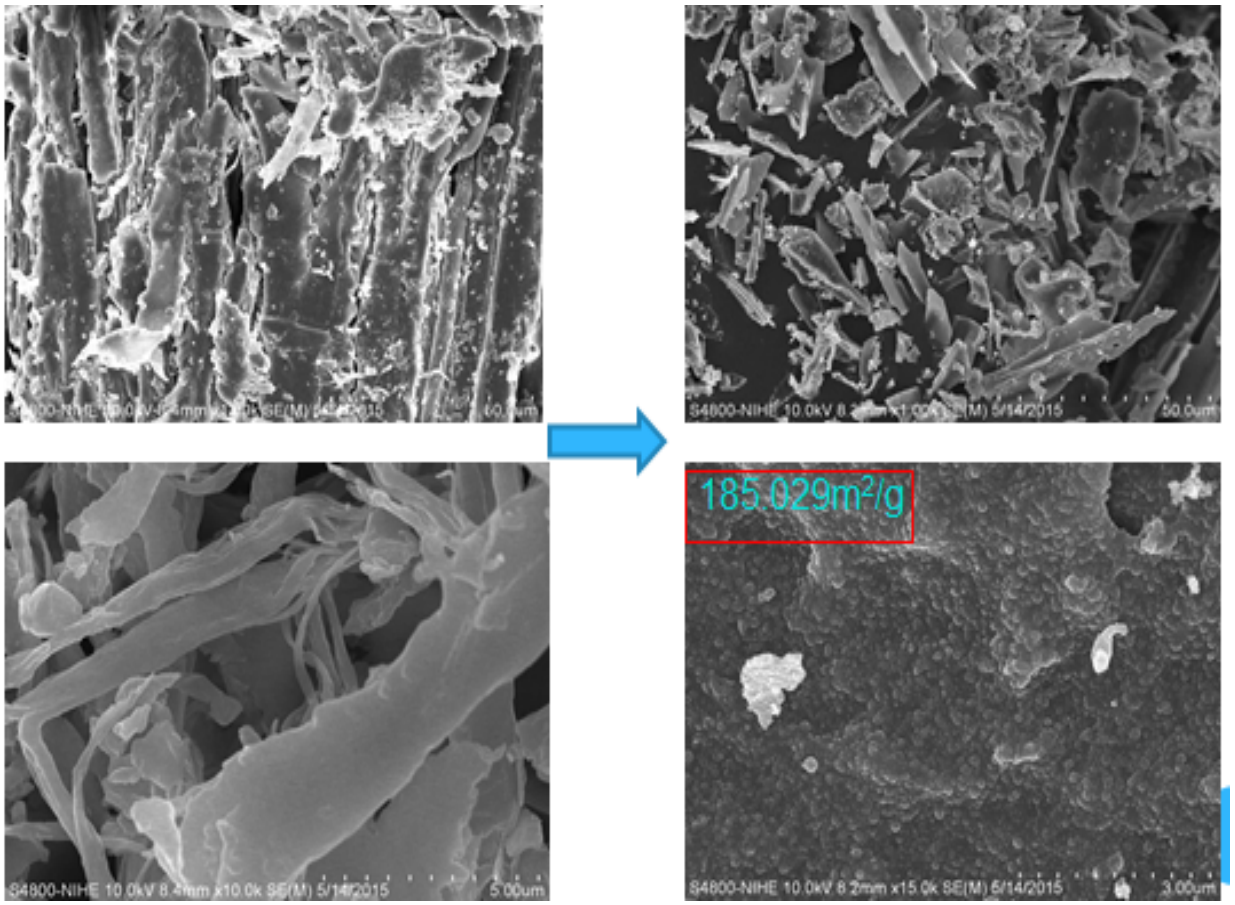


The low heating value



Gasification efficiency

EVALUATION OF CHAR PROPERTIES AFTER GASIFICATION



- Char has BET surface area very large, 185m^2/g
- Acacia wood has fibre structure but char remains after gasification has porous textural structure

➔ The application of acacia woodchips char for catalyts for remove tar

CONCLUSION

- Evaluation and analysis of biomass properties in Vietnam, choosing suitable materials for gasification system
- Outlining three reaction zone of the thermogravimetric analysis of biomass and the determination of the kinetic parameters of Acacia woodchip
- When 30% oxygen enriched air is used in the gasifier, the quality of combustible gas components will be improved remarkble from 30-40% of total volume, tar content decreases from 120 to 30mg/Nm^3

KNOWLEDGMENT

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The first anniversary events of the Clean Energy and Sustainable Development lab

Air gasification of acacia woodchips in an downdraft gasifier

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Abstract

Producer gas from biomass gasification can be used to produce chemicals or generate power. The fuel properties of acacia woodchips such as ultimate, proximate, heating values were investigated. Acacia woodchips gasification was investigated by downdraft gasifier at HUST. Main composition of producer gas include hydrogen, carbon monoxide, carbon dioxide was analyzed in gas chromatography with TCD detector. It was found that H2, CO, CO2 composition was about 14-20%, 11-22% and 13-18%, respectively. The producer gas calorific value was about 3,5 - 5,4 MJ m-3. The air flow rate was controlled ER from 0,24-0,34 and it influence on both the combustible constituents of producer gas, calorific value and gasification efficiency. The result showed that the calorific value of producer gas was 5.4 MJ m-3 and gasification efficiency attained 65,8 % with ER equal to 0,34. Acacia woodchips could successfully be used as feedstock for downdraft gasifier.

Thanks for your attention!

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